Project Title:
A study of geomagnetic storms using global MHD and kentic radiation belt simulations

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Project Information:
The goal of this project is to conduct a parametric study of various solar wind drivers of geomagnetic activity in order to understand their effects on the magnetosphere - ionosphere system, including the radiation belts. The polarity of the magnetic field orientation of magnetic clouds appears to be ordered by solar cycle and may have a determining role on geoeffectiveness when it impacts the magnetosphere. Furthermore, magnetic clouds are often accompanied by interplanetary shocks, high speed streams, and trailing density enhancements. The development of an understanding of the fundamental physics involved in these interactions is an explicit goal of this proposal. This effort is an outgrowth of two projects that have been undertaken to successfully model geomagnetic storms. The Lyon-Fedder-Mobarry (LFM) global MHD code has been used to simulate the magnetosphere under a variety of solar wind conditions including the January 10-11, 1997 Magnetic Cloud event. A 2D relativistic guiding center test particle code has been developed which can use the equatorial electric and magnetic fields from the LFM as input to model the evolution of the radiation belts. It has been used to model the electron energization and transport during the January 10-11 event, the radial transport and trapping of solar energetic protons to form a new proton belt during the March 24, 1991 storm, and eight other storms simulated approaching the current solar maximum. In the three year proposed project we will conduct a series of MHD simulations using both L1-measured solar wind conditions and idealized parameters to test model sensitivity to different solar wind conditions. The study will focus on 1) varying the polarity of magnetic clouds, 2) varying the speed of an ICME shock and 3) high speed solar wind conditions in the absence of an ICME. The differences between configurations will be quantified by using proxies from the ionospheric energy deposition, D_{st}, and AE. In addition, the effects of these configurations on the radiation belts will be compared with observations from the Polar, SAMPEX and HEO spacecraft by using the results of the guiding center test particle code. The project, under the direction of Dr. Mary K. Hudson, will utilize the significant expertise of the Space Plasma group at Dartmouth College, including Dr. John Lyon, Dr. Michael Wiltberger, as well as graduate students.

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during geomagnetic storms, Geophysical Research Letters, Volume 32, Issue 6, CiteID L06108, doi: 10.1029/2005GL022373